FORM PTO-1390 (Modified) (REV 11-98) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	U.S APPLICATION NO (IF KNOWN, SEE 37 CFR
66455-202-5	09/937399

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/GB00/01162	24 MARCH 2000	26 MARCH 1999

TITLE OF INVENTION

WHIPSTOCK CASING MILLING SYSTEM

APPLICANT(S) FOR DO/EO/US

MCGARIAN, Bruce; DEWEY, Charles H.

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☒ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☐ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☒ A copy of the International Search Report (PCT/ISA/210).
8. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☒ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
9. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
10. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included.
15. ☒ A **FIRST** preliminary amendment.
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ Certificate of Mailing by Express Mail
20. ☒ Other items or information:

Copy of WO 00/58594
Information Data Sheet

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
09/937399	PCT/GB00/01162	66455-202-5

21. The following fees are submitted:.

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
☐	Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO	**$1,000.00**
☒	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but Internation Search Report prepared by the EPO or JPO	**$860.00**
☐	International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	**$710.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4)	**$690.00**
☐	International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4)	**$100.00**

ENTER APPROPRIATE BASIC FEE AMOUNT =	**$860.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$130.00**	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE		
Total claims	15 - 20 =	0	x $18.00	**$0.00**	
Independent claims	3 - 3 =	0	x $80.00	**$0.00**	
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**	
TOTAL OF ABOVE CALCULATIONS =				**$990.00**	
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) **(check if applicable)**.			☐	**$0.00**	
SUBTOTAL =				**$990.00**	
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**	
TOTAL NATIONAL FEE =				**$990.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).**			☐	**$0.00**	
TOTAL FEES ENCLOSED =				**$990.00**	
				Amount to be: refunded	$
				charged	$

☐ A check in the amount of to cover the above fees is enclosed.

☒ Please charge my Deposit Account No. **04-2223** in the amount of **$990.00** to cover the above fees.
A duplicate copy of this sheet is enclosed.

☒ The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **04-2223** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

LAWRENCE R. RADANOVIC
CUSTOMER NO. 25269

Lawrence R. Radanovic
SIGNATURE

LAWRENCE R. RADANOVIC
NAME

23,077
REGISTRATION NUMBER

26 September 2001
DATE

66455-202-5

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	)	PATENT
	)	
Bruce MCGARIAN et al.	)	
	)	
Serial No.: (based on PCT/GB00/01162)	)	
	)	
Filed: September 26, 2001	)	ATTN BOX PCT

Whipstock Casing Milling System

PRELIMINARY AMENDMENT

September 26, 2001

Box PCT Application
Assistant Director for Patents
Washington, D.C. 20231

Sirs:

Before examination, please amend the above-identified application as follows:

IN THE CLAIMS:

1. A whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock having a whipface, the whipface comprising a relatively steep ramp surface and one of a relatively shallow ramp surface or parallel surface meeting the relatively steep ramp surface at a juncture, said surfaces being one of ramped or parallel relative to a longitudinal axis of the whipstock and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that

of the one of the relatively shallow ramp surface or parallel surface; a window mill secured to the whipstock adjacent the relatively steep ramp surface and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill being deflected by the relatively steep ramp surface laterally into the casing as the window mill is rotated about the rotational axis thereof and forced along the relatively steep ramp surface towards the one of the relatively shallow ramp or parallel surface; and a protrusion provided on the whipface, the protrusion forming an extension of the relatively steep ramp surface of the whipface, wherein during use of the system, the diameter of the window mill is greater than the distance from the juncture to the radially opposite outwardly facing surface of casing, and wherein the protrusion reduces damage to the relatively steep ramp surface.

2. A whipstock casing milling system as claimed in claim 1, wherein the window mill comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to an angle of the relatively steep ramp surface to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centered on the rotational axis of the window mill and having a radial thickness greater than a radial thickness of the protrusion.

3. A whipstock casing milling system as claimed in claim 1, wherein the protrusion is provided on the one of the relatively shallow ramp or parallel surface of the whipface.

4. A whipstock casing milling system as claimed in claim 1, wherein the protrusion is removably secured to the whipface.

5. A whipstock casing milling system as claimed in claim 3, wherein the protrusion is removably secured to the whipface by means of at least one threaded fastener.

6. A whipstock casing milling system as claimed in claim 1, wherein the protrusion comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock as the relatively steep ramp surface.

7. A whipstock casing milling system as claimed in claim 6, wherein said ramped surface of the protrusion and the relatively steep ramp surface are ramped at an angle of 15° relative to the longitudinal axis of the whipstock.

8. A method of using a whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock having a whipface, the whipface comprising a relatively steep ramp surface and one of a relatively shallow ramp surface or parallel surface meeting the relatively steep ramp surface at a juncture, said surfaces being one of ramped or parallel relative to a longitudinal axis of the whipstock, and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the one of the relatively shallow ramp surface or parallel surface; a window mill secured to the whipstock adjacent the relatively steep ramp surface and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill by the relatively steep ramp surface laterally into the

casing as the window mill is rotated and forced along the relatively steep ramp surface towards the one of the relatively shallow ramp or parallel surface; and a protrusion provided on the whipface, the protrusion forming an extension of the relatively steep ramp surface of the whipface during use of the system; wherein the method comprises the step of locating said whipstock casing milling system in a wellbore casing so that the juncture and the radially opposite outwardly facing surface of casing are spaced from one another by a distance less than the diameter of the window mill.

9. A whipstock casing milling system comprising: a whipstock having a whipface, the whipface comprising a relatively steep ramp surface and one of a relatively shallow ramp surface or parallel surface meeting the relatively steep ramp surface at a juncture, said surfaces being one of ramped or parallel relative to the longitudinal axis of the whipstock and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill secured to the whipstock adjacent the relatively steep ramp surface and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill being deflected by the relatively steep ramp surface laterally into the casing as the window mill is rotated and forced along the relatively

steep ramp surface towards the relatively shallow ramp or parallel surface; and a protrusion provided on the whipface, the protrusion forming an extension of the relatively steep ramp surface of the whipface so as to reduce damage to the relatively steep ramp surface at the juncture of the relatively steep ramp surface and the relatively shallow ramp or parallel surface during use of the system; wherein the protrusion and whipstock are discrete components.

10. A whipstock casing milling system as claimed in claim 9, wherein the window mill comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centered on the rotational axis of the window mill and having a radial thickness greater than the radial thickness of the protrusion.

11. A whipstock casing milling system as claimed in claim 9, wherein the protrusion is provided on the relatively shallow ramp or parallel surface of the whipface.

12. A whipstock casing milling system as claimed in claim 9, wherein the protrusion is removably secured to the whipface.

13. A whipstock casing milling system as claimed in claim 12, wherein the protrusion is removably secured to the whipface by means of at least one threaded fastener.

14. A whipstock casing milling system as claimed in claim 9, wherein the protrusion comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock as the relatively steep ramp surface.

15. A whipstock casing milling system as claimed in claim 14, wherein said ramped surface of the protrusion and the relatively steep ramp surface are ramped at an angle of 15° relative to the longitudinal axis of the whipstock.

REMARKS

All the claims have been amended to more closely conform the application to U.S. standards. No new matter has been introduced, and all multiple dependent claims have been cancelled.

Attached is a marked-up version of the changes made to the claims by the current Preliminary Amendment.

Entry is believed in order.

Respectfully submitted,

Lawrence R. Radanovic, Reg. No. 23,077
Customer No. 25269

Attorney for Applicants

Versions with Markings to Claims to Show Changes

1. A whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock [(44)] having a whipface, the whipface comprising a relatively steep ramp surface [(45)] and one of a relatively shallow ramp surface or parallel surface [(46)] meeting the relatively steep ramp surface [(45)] at a juncture [(A)], said surfaces [(45,46)] being one of ramped or parallel relative to [the] a longitudinal axis of the whipstock [(44)] and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the one of the relatively shallow ramp surface or parallel surface; a window mill [(32)] secured to the whipstock [(44)] adjacent the relatively steep ramp surface [(45)] and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill [(32)] being deflected by the relatively steep ramp surface [(45)] laterally into the casing as the window mill [(32)] is rotated about the rotational axis thereof and forced along the relatively steep ramp surface [(45)] towards one of the relatively shallow ramp or parallel surface [(46)]; and a protrusion [(B)] provided on the whipface, the protrusion [(B)] forming an

extension of the relatively steep ramp surface [(45)] of the whipface, [characterised in that,] wherein during use of the system, the diameter of the window mill [(32)] is greater than the distance from the juncture [(A)] to the radially opposite outwardly facing surface of casing, and [in that] wherein the protrusion [(B)] reduces damage to the relatively steep ramp surface [(45)].

2. A whipstock casing milling system as claimed in claim 1, wherein the window mill [(32)] comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to [the] an angle of the relatively steep ramp surface [(45)] to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centered on the rotational axis of the window mill [(32)] and having a radial thickness greater than [the] a radial thickness of the protrusion [(B)].

3. A whipstock casing milling system as claimed in claim 1 [or 2], wherein the protrusion [(B)] is provided on the one of the relatively shallow ramp or parallel surface [(46)] of the whipface.

4. A whipstock casing milling system as claimed in [any of the preceding claims] claim 1, wherein the protrusion [(B)] is removably secured to the whipface.

5. A whipstock casing milling system as claimed in claim 3, wherein the protrusion [(B)] is removably secured to the whipface by means of at least one threaded fastener.

6. A whipstock casing milling system as claimed in [any of the preceding claims] claim 1, wherein the protrusion [(B)] comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock [(44)] as the relatively steep ramp surface [(45)].

7. A whipstock casing milling system as claimed in claim 6, wherein said ramped surface of the protrusion [(B)] and the relatively steep ramp surface [(45)] are ramped at an angle of 15° relative to the longitudinal axis of the whipstock [(44)].

8. A method of using a whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing

surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock [(44)] having a whipface, the whipface comprising a relatively steep ramp surface [(45)] and one of a relatively shallow ramp surface or parallel surface [(46)] meeting the relatively steep ramp surface [(45)] at a juncture [(A)], said surfaces [(45,46)] being one of ramped or parallel relative to [the] a longitudinal axis of the whipstock [(44)], and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the one of the relatively shallow ramp surface or parallel surface; a window mill [(32)] secured to the whipstock [(44)] adjacent the relatively steep ramp surface [(45)] and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill [(32) being deflected] by the relatively steep ramp surface [(45)] laterally into the casing as the window mill [(32)] is rotated and forced along the relatively steep ramp surface [(45)] towards the one of the relatively shallow ramp or parallel surface [(46)]; and a protrusion [(B)] provided on the whipface, the protrusion [(B)] forming an extension of the relatively steep ramp surface [(45)] of the whipface during use of the system; wherein the method comprises the step of locating said whipstock casing milling system in a wellbore casing so that the juncture [(A)] and

the radially opposite outwardly facing surface of casing are spaced from one another by a distance less than the diameter of the window mill [(32)].

9. A whipstock casing milling system comprising: a whipstock [(44)] having a whipface, the whipface comprising a relatively steep ramp surface [(45)] and one of a relatively shallow ramp surface or parallel surface [(46)] meeting the relatively steep ramp surface [(45)] at a juncture [(A)], said surfaces [(45,46)] being one of ramped or parallel relative to the longitudinal axis of the whipstock [(44)] and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill [(32)] secured to the whipstock [(44)] adjacent the relatively steep ramp surface [(45)] and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill [(32)] being deflected by the relatively steep ramp surface [(45)] laterally into the casing as the window mill [(32)] is rotated and forced along the relatively steep ramp surface [(45)] towards the relatively shallow ramp or parallel surface [(46)]; and a protrusion [(B)] provided on the whipface, the protrusion [(B)] forming an extension of the relatively steep ramp surface [(45)] of the whipface so as to reduce damage to the relatively steep ramp surface [(45)] at the juncture [(A)] of the relatively

steep ramp surface [(45)] and the relatively shallow ramp or parallel surface [(46)] during use of the system; wherein the [whipstock casing milling system being characterised in that the] protrusion [(B)] and whipstock [(44)] are discrete components.

10. A whipstock casing milling system as claimed in claim 9, wherein the window mill [(32)] comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface [(45)] to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centered on the rotational axis of the window mill [(32)] and having a radial thickness greater than the radial thickness of the protrusion [(B)].

11. A whipstock casing milling system as claimed in claim 9 [or 10], wherein the protrusion [(B)] is provided on the relatively shallow ramp or parallel surface [(46)] of the whipface.

12. A whipstock casing milling system as claimed in [any of claims 9 to 11] claim 9, wherein the protrusion [(B)] is removably secured to the whipface.

13. A whipstock casing milling system as claimed in claim 12, wherein the protrusion [(B)] is removably secured to the whipface by means of at least one threaded fastener.

14. A whipstock casing milling system as claimed in [any of claims 9 to 13] claim 9, wherein the protrusion [(B)] comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock [(44)] as the relatively steep ramp surface [(45)].

15. A whipstock casing milling system as claimed in claim 14, wherein said ramped surface of the protrusion [(B)] and the relatively steep ramp surface [(45)] are ramped at an angle of 15° relative to the longitudinal axis of the whipstock [(44)].

WHIPSTOCK CASING MILLING SYSTEM

This invention relates to a whipstock casing milling system, and more particularly to such a system in which a window mill is secured to the whipstock so that the system may be run into a well, set and operated to open a window in the casing in a single trip.

A one trip casing milling system as described above is shown in our British patent publication GB2312702A. In the system described in this patent specification, a window mill is secured by means of a shear bolt to the end of the whipstock. The window mill includes a tapered end, the taper of which matches the ramp angle of the end portion of the whipstock. This ramp angle is relatively steep (typically 15°) so that, at the start of casing milling, the window mill is forced rapidly into the casing in order to form an initial opening.

Whilst this system for effecting the initial break through of the casing offers considerable advantages over the prior art, the arrangement does have the disadvantage that the area of contact between the tapered portion of the window mill and the initial steep ramp surface on the whipstock (i.e. the bearing area) decreases as the window mill begins to penetrate the casing. Although the whipstock ramp continues to apply a lateral force to the window mill the reaction force on the whipstock becomes progressively concentrated on a small region of the ramp face. Even though the whipstock ramp may be hardened, the fact that the reaction force from the window mill is concentrated on a relatively small area of the ramp tends to lead to wear of the ramp. This wear is particularly noticeable at the point where there is a change of whipstock angle at the bottom end of the initial steep ramp portion. Immediately before the casing milling tool begins to run down the relatively shallow angled (or parallel) portion of the whipstock below the steep ramp, the entire reaction force applied by the window mill to the whipstock is concentrated in this small area. Even if the whipstock is extensively hardened in this area, wear will

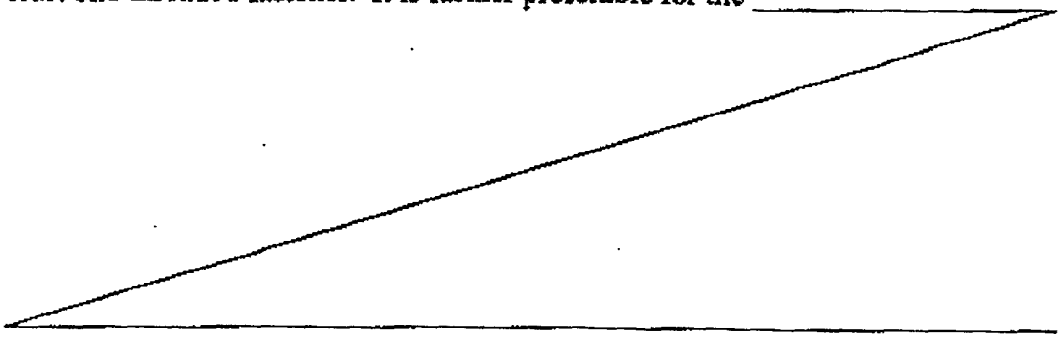
inevitably occur. One result of this wear is that the window in the casing is not opened up as quickly as might be expected from the initial (pre-wear) profile of the whipstock. One prior art system according to the preamble of the appended claims (disclosed under international publication number WO 98/04804) provides a partial solution to this problem, but does not necessarily allow prevention of undesirable ramp wear under given conditions.

We have now devised a complete solution to the aforementioned problem.

A first aspect of the present invention provides a whipstock casing milling system according to the appended independent claim 1. A further aspect of the present invention provides a whipstock casing milling system according to the appended independent claim 9. A further advantageous feature is defined in the appended dependent claims 2 and 10. A yet further aspect of the present invention provides a method of using a window casing milling system according to appended independent claim 8.

The protrusion will, in practice, be milled partially or completely away during the casing milling operation. However, the existence of the protrusion prevents the excessive damage to the relatively steep ramp surface of the whipface such as has occurred in the prior art. The protrusion may be of any suitable material, for example steel of a suitable grade.

Ideally, the protrusion is provided on the relatively shallow ramp surface or parallel surface of the whipface. Preferably, the protrusion is removably secured to the whipface. The protrusion may be movably secured by means of at least one threaded fastener. It is further preferable for the



protrusion to comprise a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock as the relatively steep ramp surface. The ramped surface of the protrusion and the relatively steep ramp surface are ideally ramped at an angle of 15° relative to the longitudinal axis of the whipstock.

The invention will be better understood from the following description of a preferred embodiment thereof given by way of example only, reference being had to the accompanying drawings, wherein:

Figure 1 corresponds to Figure 4 of the above mentioned GB2312702A;

Figures 2, 3 and 4 illustrate the milling apparatus of Figure 1 in use during a casing milling operation;

Figure 5 illustrates the improvement according to the present invention; and

Figures 6, 7 and 8 illustrate the milling apparatus of Figure 5 in use during a casing milling operation.

Turning firstly to Figure 1, there is shown a portion of the casing milling system of GB2312702A. Reference should be had to the text of this patent publication for further description of the illustrated system. For the present purposes however, it is sufficient to note that the illustrated system comprises a window mill 32 which is secured to a whipstock 44 by a shear bolt 39. The whipstock has a whipface which includes a relatively steep starter surface 45 followed by a vertical surface 46 (i.e. a surface parallel to the longitudinal axis of the casing). The relatively steep starter surface 45 meets the vertical surface 46 at a transition point A. In use, after the illustrated casing milling system has been run in hole, a packer or anchor secured to the bottom of the whipstock is set and the window mill 32 is released by shearing the shear bolt 39. The drill string is then rotated and weight applied to the window mill 32. The window mill runs up the relatively steep starter surface 45 on the

whipstock and is thereby forced laterally into the casing on the side thereof opposite the whipstock. The casing is disintegrated and the window mill moves downwardly.

It will be appreciated that immediately before the window mill moves on to the vertical section 46 of the whipface, the entire reaction force of the window mill onto the whipface is taken by the portion of the starter surface 45 immediately adjacent the juncture A. This results in wear of the whipface at this point with the result that the window mill is not forced cleanly through the casing as intended in the original design.

Indeed, wear of the steep starter surface 45 typically begins well before the window mill 32 progresses onto the vertical surface 46. This is illustrated in Figures 2, 3 and 4 of the accompanying drawings. In Figure 2, the window mill 32 is shown at the foot of the steep starter surface 45 prior to commencing cutting of the well casing. As the window mill 32 is pushed up the starter surface 45, the bearing area (i.e. the area of contact between the window mill and the starter surface) reduces. The lateral reaction force applied by the well casing onto the window mill does not reduce however and indeed tends to increase with the depth of cut. The stress in the starter surface 45 produced by the window mill 32 is a function of the lateral reaction force and the bearing area. The dependency is such that the stress in the starter surface 45 increases both as the lateral reaction force increases and as the bearing area decreases. Accordingly, as the window mill 32 moves up the starter surface 45, the stress in the starter surface 45 will increase until a critical level is attained, at which point, the starter surface 45 will begin to disintegrate. The minimum bearing area Z before disintegration of the starter surface 45 begins is shown in Figure 3. As the window mill 32 progresses up the starter surface 45 so as to reduce the bearing area below the minimum value, disintegration of the whipstock begins and the angle of the starter surface 45 is effectively reduced. An undercutting of the well casing results. Depending upon the operational

circumstances (including, for example, the relative hardness of the whipstock and the well casing), the angle of the starter surface 45 can, in an extreme case be reduced to zero (see Figure 4). In this event, a window in the well casing will not be formed.

Referring now to Figure 5, the above outlined problem is solved by means of a protrusion B which is provided on the whipface immediately below the lower end of the starter surface 45. The protrusion B in effect extends the starter surface 45 downwardly of the well. The effect of the protrusion is to provide extra support for the reaction forces imposed on the whipface by the window mill and thereby reduce or prevent the undesired wearing away of the starter surface 45 itself. In practice, the protrusion will in general be milled away in use by the window mill. However, the existence of the protrusion ensures that adequate lateral movement of the window mill is achieved before the window mill starts travelling down the vertical surface 46. The protrusion can be of any suitable material and can be secured to the whipface by any convenient means, for example by means of screws or by welding.

Use of a whipstock casing milling system according to the present invention is shown in Figures 6, 7 and 8 of the accompanying drawings. In Figure 6, the window mill 32 is shown at the foot of the steep starter surface 45 prior to commencing cutting of the well casing. As the window mill 32 is pushed up the starter surface 45, the bearing area initially remains constant due to the provision of the protrusion B. It is only as the window mill 32 is pushed beyond the extended starter surface 45 (see Figure 7) that the bearing area begins to reduce. This reduction in bearing area contributes to an increase in the stress within the starter surface 45 and the extension provided by protrusion B. However, the protrusion B is sized so that starter surface 45 is sufficiently extended for attainment of the critical stress level to be delayed until the required lateral displacement of the window mill 32 has occurred. As intimated

above, this required lateral displacement occurs when the window mill 32 (specifically the largest outer diameter of the window mill 32) reaches the juncture A between the vertical section 46 of the whipface and the (unexteneded) starter surface 45.

The extension to the starter surface 45 provided by the protrusion B is sized so as to provide a contact area with the window mill 32 substantially equal to the minimum bearing area Z indicated in Figure 3 (assuming the protrusion B is of an identical material to that of the whipstock and the forces exerted by the window mill 32 having reached juncture A (see Figure 7) are identical to those exerted by the window mill 32 located in the critical position shown in Figure 3). A skilled person will be capable of calculating the precise dimensions of the protrusion B in view of known operating circumstances.

Once the window mill 32 has progressed up the starter surface 45 to the position indicated in Figure 7, the lateral reaction forces exerted by the window mill 32 in cutting into the wellbore side are borne solely by the protrusion B. The arrangement is such that the critical stress level is not attained until the window mill 32 progresses to or beyond the position of Figure 7. When the critical stress level is attained, the protrusion B is either partially or wholly (as shown in Figure 8) milled away. The starter surface 45 and vertical section 46 of the whipface remain substantially undamaged and a window is opened as required. The whipstock itself may be used in future operations with a replacement protrusion B.

The present invention is not limited to the specific embodiment described above. Alternative arrangements and suitable materials will be apparent to a reader skilled in the art.

CLAIMS:

1. A whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44) and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32) is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface, characterised in that, during use of the system, the diameter of the window mill (32) is greater than the distance from the juncture (A) to the radially opposite outwardly facing surface of casing, and in that the protrusion (B) reduces damage to the relatively steep ramp surface (45).

2. A whipstock casing milling system as claimed in claim 1, wherein the window mill (32) comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface (45) to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centred on the rotational axis of the

window mill (32) and having a radial thickness greater than the radial thickness of the protrusion (B).

3. A whipstock casing milling system as claimed in claim 1 or 2, wherein the protrusion (B) is provided on the relatively shallow ramp or parallel surface (46) of the whipface.

4. A whipstock casing milling system as claimed in any of the preceding claims, wherein the protrusion (B) is removably secured to the whipface.

5. A whipstock casing milling system as claimed in claim 3, wherein the protrusion (B) is removably secured to the whipface by means of at least one threaded fastener.

6. A whipstock casing milling system as claimed in any of the preceding claims, wherein the protrusion (B) comprises a surface which is ramped at the same angle relative to the longitudinal axis of the whipstock (44) as the relatively steep ramp surface (45).

7. A whipstock casing milling system as claimed in claim 6, wherein said ramped surface of the protrusion (B) and the relatively steep ramp surface (45) are ramped at an angle of 15° relative to the longitudinal axis of the whipstock (44).

8. A method of using a whipstock casing milling system for forming a window in the casing of a wellbore, the casing having an inwardly facing surface which defines the inside diameter of the casing and an outwardly facing surface which defines the outside diameter of the casing, the whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising

a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44), and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32) is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface during use of the system; wherein the method comprises the step of locating said whipstock casing milling system in a wellbore casing so that the juncture (A) and the radially opposite outwardly facing surface of casing are spaced from one another by a distance less than the diameter of the window mill (32).

9. A whipstock casing milling system comprising: a whipstock (44) having a whipface, the whipface comprising a relatively steep ramp surface (45) and a relatively shallow ramp surface or parallel surface (46) meeting the relatively steep ramp surface (45) at a juncture (A), said surfaces (45,46) being ramped or parallel relative to the longitudinal axis of the whipstock (44) and the relatively steep ramp surface having an angle to the longitudinal axis of the whipstock greater than that of the relatively shallow ramp surface or parallel surface; a window mill (32) secured to the whipstock (44) adjacent the relatively steep ramp surface (45) and operable in use to form an opening in a wellbore casing in which the whipstock casing milling system is located, the window mill (32) being deflected by the relatively steep ramp surface (45) laterally into the casing as the window mill (32)

is rotated and forced along the relatively steep ramp surface (45) towards the relatively shallow ramp or parallel surface (46); and a protrusion (B) provided on the whipface, the protrusion (B) forming an extension of the relatively steep ramp surface (45) of the whipface so as to reduce damage to the relatively steep ramp surface (45) at the juncture (A) of the relatively steep ramp surface (45) and the relatively shallow ramp or parallel surface (46) during use of the system; the whipstock casing milling system being characterised in that the protrusion (B) and whipstock (44) are discrete components.

10. A whipstock casing milling system as claimed in claim 9, wherein the window mill (32) comprises a cutting surface arranged with an angle to the rotational axis of the window mill substantially identical to the angle of the relatively steep ramp surface (45) to the longitudinal axis of the whipstock, said cutting surface occupying an annular zone centred on the rotational axis of the window mill (32) and having a radial thickness greater than the radial thickness of the protrusion (B).

11. A whipstock casing milling system as claimed in claim 9 or 10, wherein the protrusion (B) is provided on the relatively shallow ramp or parallel surface (46) of the whipface.

12. A whipstock casing milling system as claimed in any of claims 9 to 11, wherein the protrusion (B) is removably secured to the whipface.

13. A whipstock casing milling system as claimed in claim 12, wherein the protrusion (B) is removably secured to the whipface by means of at least one threaded fastener.

14. A whipstock casing milling system as claimed in any of claims 9 to 13, wherein the protrusion (B) comprises a surface which is ramped at the same

angle relative to the longitudinal axis of the whipstock (44) as the relatively steep ramp surface (45).

15. A whipstock casing milling system as claimed in claim 14, wherein said ramped surface of the protrusion (B) and the relatively steep ramp surface (45) are ramped at an angle of 15° relative to the longitudinal axis of the whipstock (44).

Fig.1.

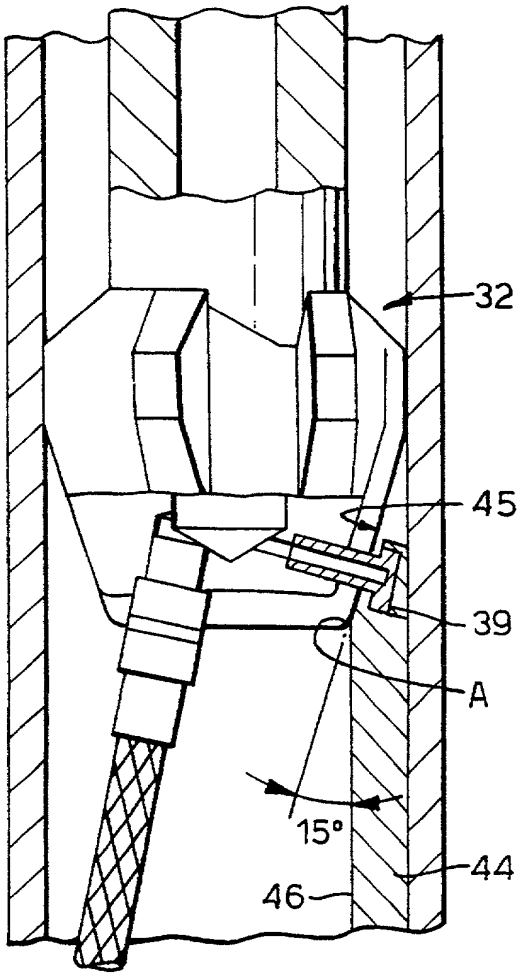


Fig.2.

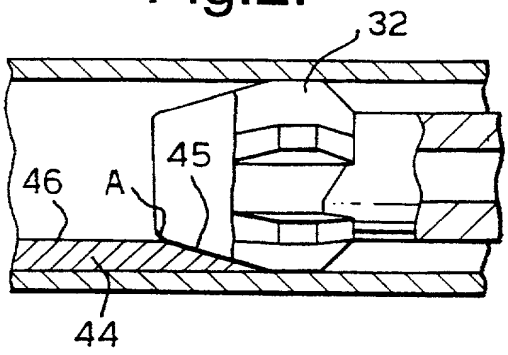


Fig.3.

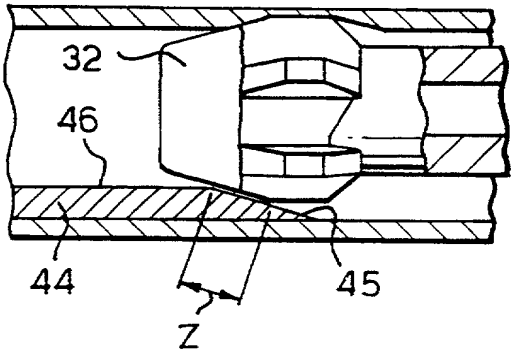


Fig.4.

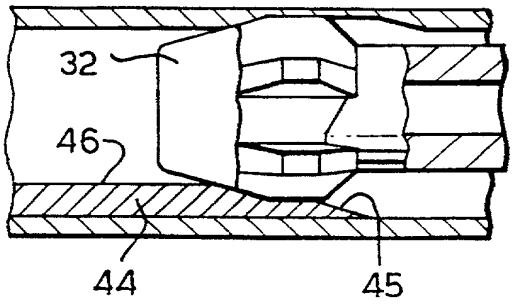


Fig.5.

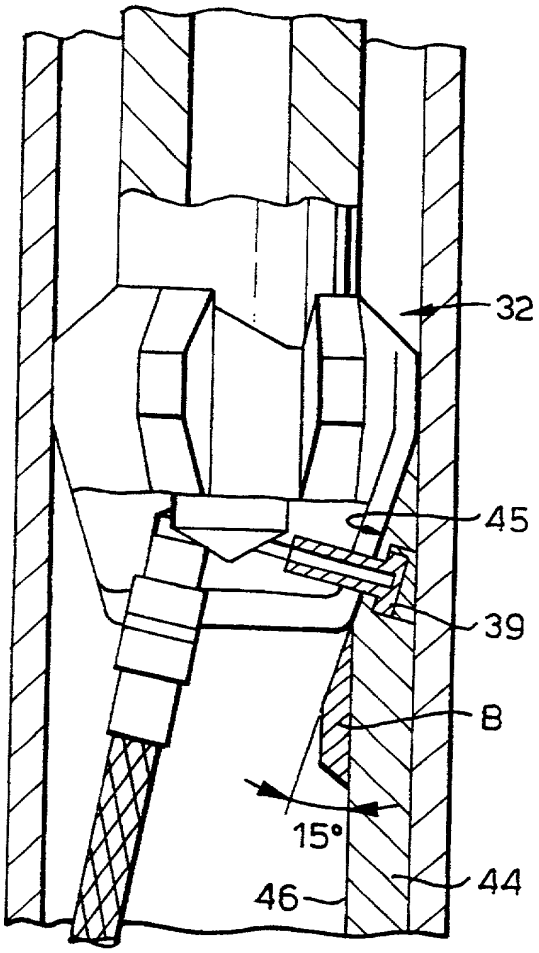


Fig.6.

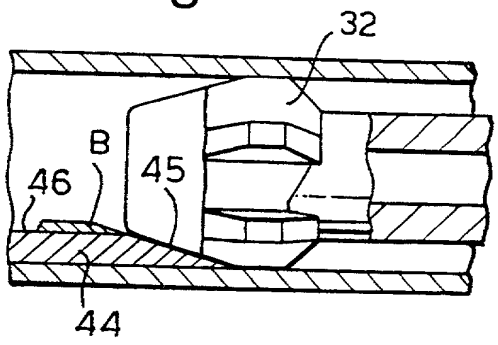


Fig.7.

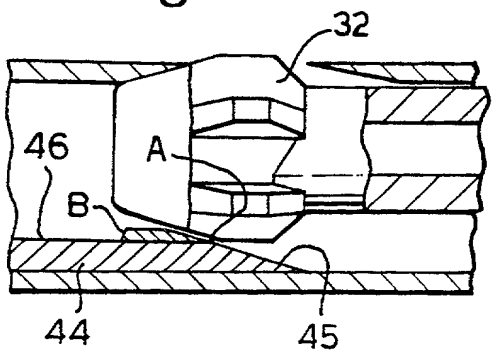
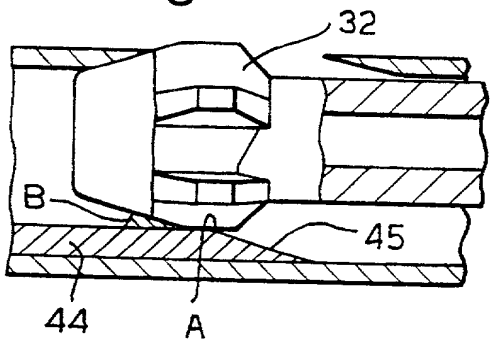


Fig.8.



#3

COMBINED DECLARATION AND POWER OF ATTORNEY FOR **UTILITY** PATENT APPLICATION (Includes PCT)	Attorney Docket No. 66455-202-5

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name; that

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: WHIPSTOCK CASING MILLING SYSTEM

the specification of which (check one): [ ] is attached hereto.

[ ] was filed on _____ as Application Serial No. 09/937,399 and was amended on _____.

[x] was filed 24 March 2000 as PCT International Application No. PCT/GB00/01162 and was amended under PCT Article 19 on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I do not know and do not believe the claimed invention was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months prior to this application.

I hereby claim foreign priority benefits under Title 35, United States Code §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application(s) on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
9907116.9 (Number)	Great Britain (Country)	26 March 1999 Day/Month/Year Filed	[x] Yes	[ ] No
_____ (Number)	_____ (Country)	_____ Day/Month/Year Filed	[ ] Yes	[ ] No
_____ (Number)	_____ (Country)	_____ Day/Month/Year Filed	[ ] Yes	[ ] No

I hereby claim the benefit under Title 35, United States Code, §119 (e) of any United States provisional application(s) listed below:

Application No.	Day/Month/Year Filed	Application No.	Day/Month/Year Filed

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior application(s) in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56(a) which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Attorney Docket No. 66455-202-5

Application Serial No.	Filing Date	Status (patented, pending, abandoned)
Application Serial No.	Filing Date	Status (patented, pending, abandoned)

(10)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: Lawrence R Radanovic, Reg. No 23,077; Richard H. Tushin, Reg. No. 27,297; Donald N. Huff, Reg. No. 27,561; John P. DeLuca, Reg. No 25,505; Sandra S. Snapp, Reg. No. 41,444, Charles Rutherford, Reg. No. 18,933; Robert L. Kelly, Reg. No. 31,843; Ernest E. Helms, Reg. No. 29,721, William F. Kolakowski, Reg. No. 41,908; and William A. Bonk, III, Reg. No. 40,521, all of Dykema Gossett, PLLC. Direct all telephone calls to telephone no. **(202) 906-8600** and faxes to **(202) 906-8669**.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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